Microcredit from Delayed Bill Payments

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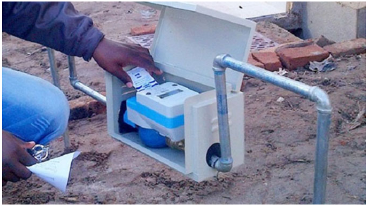
Motivation

- Households (HHs) have variable, uncertain incomes
- Smoothing consumption is costly
  - High interest rates from payday loans, credit cards, informal moneylenders, etc.
  - In Manila, only 4% have credit cards, 19% have bank accounts
- Public utilities (water, electricity, gas, etc.) may provide efficient, second-best credit by letting HHs delay their bill payments

New policies reduce delinquency

- Growing use of prepaid meters that ensure upfront payments
  - benefits $\rightarrow$ may lower prices and increase investments in quality
  - costs $\rightarrow$ no more credit from delayed bill payments

Figure: Prepaid water meter in South Africa



- **Research Question** how much do HHs value delaying their bills?
  - How credit-constrained are HHs?
  - What are the welfare effects of other payment policies (ie. prepaid meters)?

This Paper

- **Context** a regulated piped water utility in Manila
- **Data** monthly billing records from 2010-15 for 1.5 mil. connections
- **Approach** estimate a consumption/savings model where HHs choose when to pay their water bills
- **Results** monthly interest rate is 2.2% (30% annually) and willingness-to-pay for delaying bills is 70 PhP (or $1.5) per month
  - Prepaid metering (adjusting prices to cover costs) reduces welfare

Contributions to the Literature

1. Bring consumption smoothing to public utility regulation
   (McRae [2015]; Szabó [2015]; Jack and Smith [2015,2016]; Szabó and Ujhelyi [2015])
2. Estimate HH consumption/savings model with utility billing data
   (Deaton [1991]; Gourinchas and Parker [2002]; Laibson et al. [2007])
3. Measure credit constraints from billing delinquency
   (*RCTs*: Karlan and Zinman [2009]; Giné and Karlan [2014], *Village surveys*: Townsend [1994]; Townsend and Kinnan [2012]; Ligon [1994], *Natural Experiments*: Banerjee and Duflo [2012])

Model of HH consumption and savings

$$max \;\; E_t\Big[\; \sum_{\tau=t}^{\infty}(1+\delta)^{t-\tau}\; u(w_\tau, x_\tau)\;\Big]$$

$$\forall t \quad x_t \,+\, p(w_t)w_t \;=\; y_t \,+\, A_t - \frac{A_{t+1}}{1+r_a} + S_t$$

- Utility, $u(w_\tau, x_\tau) = \alpha log(w_\tau) + (1-\alpha)log(x_\tau)$ is over water, w_t, and all other goods, x_t, with discount rate, δ
- Budget constraint has water price, $p(w_t)$, and income, y_t, which takes values $(1+\theta)\bar{y}$ and $(1-\theta)\bar{y}$ with 0.5 probability
- HHs borrow and save with asset A_{t+1} where $A_{t+1} \geq -\bar{A}$ and interest rate, r_a, is equal to r_h if borrowing ($A_{t+1} \leq 0$) and r_l else
- S_t allows for borrowing from water bills (cont.)

Borrowing from water bills, S_t

- Each period, HH faces probability π of receiving a delinquency visit from the water utility
- If no visit occurs, HHs can borrow by not paying their bills

$$S_t = B_{t-1} - B_t$$
$$B_{t-1} - p(w_t)w_t \leq B_t \leq 0$$

  - B_{t-1} : last month's unpaid bill (≤ 0)
  - B_t : this month's unpaid bill $(= 0$ if $A_t > 0$ to prevent arbitrage)

- If a visit occurs, HHs can choose to disconnect $(D_t = 1)$, avoid paying their bills $(S_t = 0)$, and pay a fixed cost (f) per month for other water until they reconnect
- Otherwise, HHs pay off any unpaid bills $(S_t = B_{t-1})$ and this month's bill $(B_t = 0)$ to stay connected

Data and Sample

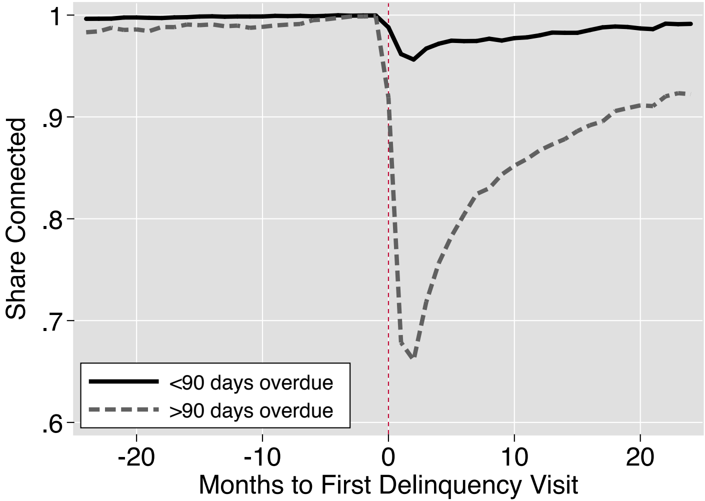
- Data
  - Monthly billing records per connection 2010-15
    (usage, payments, and delinquency visits)
  - Merge to survey data on ∼50,000 connections
    (number of HHs sharing a connection and demographics for the owner)
- Sample
  - Model single HH decisions
    - Keep residential connections that serve a single HH (67%)
  - Use delinquency visits for identification
    - Keep HHs with visits (31%)
  - Drop HHs that move
    - Drop if disconnected for the last 6 months of the sample (10%)

Descriptives

- Avg water bill is 761 PhP while avg unpaid balance is 2,416 PhP ($\sim$5% of HH income)
- HHs pay in 60% of months
- There are 1.32 delinquency visits per HH on avg
- Sample has 8,260 HHs with 61.8 obs per HH for 509,959 total obs

45 Philippine Peso (PhP) = 1 US Dollar
Avg monthly HH Income 31,910 PhP

Avg share connected around 1st delinquency visit



Estimates with simulated method of moments

Calibrated				Source
Discount rate	δ	0.015		Structural macro literature
Savings rate	r_l	0.003		World Bank
Visit risk	π	0.04		Billing data
Price	p	20.2 + 0.2w		Billing data
Mean inc. (PhP)	$\bar{y}$	31,910		HH inc. survey
Borrowing limit	$\bar{A}$	-32,250		HH inc. survey (95 pctile. of loans)
Unpaid bills limit	$\bar{B}$	-10,109		Billing data (95 pctile. of unpaid bills)
Estimated				**Moments**
Water preference	α	0.024	(0.00075)	Avg usage
Income shock size	θ	0.342	(0.0318)	Avg unpaid bills
Cost of other water	f	150.0	(34.3)	% Disc. 1-2 months post visit
Borrowing rate	r_h	0.022	(0.0055)	% Disc. 1-2 months post visit

Counterfactuals

	(1) Current	(2) No Water Borrowing
Compensating Variation (PhP)		-69.3
Mean Usage (m3)	26.58	24.22

All values are at the household-month level.

Counterfactuals

	(1) Current	(2) No Water Borrowing	(3) No Water Borrowing and Covering Costs
Compensating Variation (PhP)		-69.3	-89.4
Mean Usage (m3)	26.58	24.22	24.18
Price Intercept (PhP/m3)	20.23		20.27
Credit supply costs (PhP)	31.3		0
Marginal cost (PhP/m3)	5		5

All values are at the household-month level.

- Credit supply costs include (1) cost of delinquency visits, (2) lost revenue from HHs that move, and (3) opportunity cost of credit

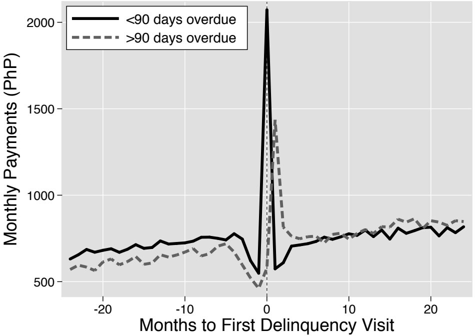
Counterfactuals

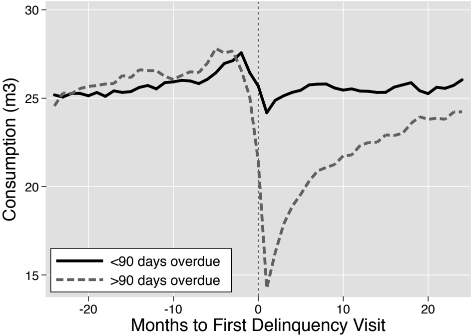
	(1) Current	(2) No Water Borrowing	(3) No Water Borrowing and Covering Costs	(4) Prepaid Metering and Covering Costs
Compensating Variation (PhP)		-69.3	-89.4	-245.5
Mean Usage (m3)	26.58	24.22	24.18	20.61
Price Intercept (PhP/m3)	20.23		20.27	27.23
Credit supply costs (PhP)	31.3		0	0
Marginal cost (PhP/m3)	5		5	5
Additional metering cost (PhP)	0		0	51

All values are at the household-month level.

Thank you!

Other outcomes relative to 1st visit





- Avg payments only include positive payments

Solving the model with a value function approach

$$V(X_t, z_t) = max_{x_t, w_t} \; u(x_t, w_t) + (1+\delta)^{-1} E\Big[V(X_{t+1} | z_t) \Big| z_{t+1}, T_{t,t+1} \Big]$$

$$s.t.$$

$$x_t + p(w_t) w_t = y_t + S_t$$

$$B_{t-1} - p(w_t) w_t (1 - D_t) \leq B_t \leq 0$$

$$X_t = [x_t, w_t, A_t, B_t, D_t] \quad \text{chosen by HH}$$

$$z_t = [y_t, visit_t]$$

$$T_{t,t+1} = [0.5\pi \;\; 0.5(1-\pi) \;\; 0.5\pi \;\; 0.5(1-\pi)] \times [1 \;\; 1 \;\; 1 \;\; 1]^{\mathsf{T}}$$